ANSWERS: Rate of reactions

1) **ANSWERS to follow in April 2014**

2) a) **Decrease concentration of a reactant and Decrease temperature.**

b) **Experiment 2 and 1**

Concentration of a reactant has decreased, which decreased the rate of reaction.

This means there are fewer reactant particles per unit volume so the collision rate decreases.

Experiment 3 and 1

Temperature is increased, so the rate of reaction increases.

This means:

The particles have more average kinetic energy and are moving faster. There will be an increase in the frequency of collisions between particles.

Particles also collide more effectively as the particles have more energy to overcome the activation energy for the reaction.

3) a) i**)** The time taken would be longer (ie, slower reaction rate).

ii) The time taken would be longer (ie, slower reaction rate).

b) For a reaction to occur particles must collide and these collisions must be effective. For a collision to be effective particles must have energy greater than the activation energy (this is the minimum energy that a particle needs to react when it collides).

When the concentration is decreased there is a decreased frequency of collisions between particles so fewer particles react. This means that the rate of reaction is decreased.

When the temperature is decreased the kinetic energy and hence the speed of reacting particles decreases. This means that particles collide less frequently. It also means that the particles collide with less energy (and less effective collision) as fewer particles have energy greater than the activation energy. The activation energy (or energy of activation) is a measure of the energy required to bring about effective particle collisions in order for reactants to form products).

In both instances (ie diluted solution, lower temperature) the solution would take longer to go cloudy as the collisions between the hydrochloric acid and the sodium thiosulfate would occur less frequently and/or the collisions would be less effective.

4) i) **A:** It has higher concentration.

It has more particles in a given volume. It has more frequent collisions. It has a higher rate of reaction.

ii) Granules have greater surface area. Thus more Zn atoms are exposed. Thus more frequent collisions occur.

iii) The change causes a lower rate of reaction. It lowers kinetic energy. It causes less frequent collisions. Thus fewer particles have EA. Thus fewer collisions are successful.

5)

	Factor	**Effect**
Change One	concentration	decrease
Change Two	temperature	increase
Change Three	surface area	decrease

The concentration of hydrochloric acid has decreased, so there are fewer particles per unit volume of acid to react at any one time. Lower concentration means that there is a decrease in the frequency of collisions, so the frequency of effective collisions decreases. Hence the reaction occurs more slowly.

6) a) Rate of reaction can be increased by
• increasing the temperature (heat the reaction)
• increasing the surface area of the calcium carbonate (use powdered calcium carbonate)
• increasing the concentration of hydrochloric acid. (not reactants).

b) **Line A** – Beaker 3
Line B – Beakers 1 and 2
Beakers 1 and 2 have the same concentration of HCl and Beaker 3 has a lower concentration of HCl.

Line B corresponds to beakers 1 and 2 because it is steeper showing a faster rate of reaction. In Beakers 1 and 2, there are more reactant particles per unit volume compared to Beaker 3, so the concentration is greater. As the concentration of reactants is increased, the collision rate of reactant particles increases, so there are more successful / effective collisions and the reaction rate is increased. Hence a steeper line on the graph

Line A corresponds to beaker 3 because it is less steep and shows a slower rate of reaction. In beaker 3 there are fewer reactant particles per unit volume compared to beakers 1 and 2, so the concentration is lower. As the concentration of the reactants is decreased, the collision rate of the reactant particles decreases, so there are fewer successful / effective collisions and the rate of the reaction is decreased.

c) i) States that as temperature increases the rate of reaction increases / time taken for the solution to decolourise decreases.
ii) This is because as temperature increases, the molecules have more kinetic energy / higher energy and moving faster. There will be an increase in the frequency of collisions between particles. Particles also collide more effectively when they actually do collide. There are more effective / successful collisions because more particles have enough kinetic energy to overcome the activation energy for the reaction. Leading to an increased rate of reaction

7) a) The reaction rate is increased when manganese dioxide is added.
b) The catalyst increases the reaction rate by providing an alternative pathway of lower activation energy. Therefore a greater proportion of collisions (in a given time) have the required activation energy and are successful.

Time period A:

Initially the reaction rate is high, as the concentration of reactants in the solution is high. As the reaction proceeds, the reaction rate decreases because the concentration of reactants is decreased, the collision rate of reactant particles is decreased.

Time period B:

The reaction has stopped / zero reaction rate. There are no more (or few) H_2O_2 particles left to collide, so no more oxygen is being produced.

Rate of reaction can be increased by
- increasing the temperature (heat the reaction)
- increasing the surface area of the calcium carbonate (use powdered calcium carbonate)
- increasing the concentration of hydrochloric acid. (not reactants).

8) a) Solution has been diluted so fewer acid particles in same volume; collision rate decreases so number of effective / successful collisions decreases. Hence, rate decreases.

b) Carry out two experiments, one with Cu and the other without. Both experiments use same mass of zinc and same conc. and volume of acid.

Time how long **each** reaction takes, eg bubbles formed in time period, volume of gas in time period, length of time for reaction to complete.

Use a weighed mass of Cu and reweigh at the end to determine whether it has been used in the reaction.

An increased reaction rate with Cu not used up will mean it is a catalyst for the reaction.

9) Surface area:
Greater surface area: greater rate
Greater surface area hence an increase in the frequency of collisions.

10) a) MnO_2 is catalyst for the reaction.
The catalyst provides an alternative pathway of lower activation energy for the reaction. Thus molecules which previously did not have enough energy to react now reach the lowered activation energy upon collision. The successful collision rate is therefore increased, so that the reaction rate is increased.
As the manganese dioxide (catalyst) is not used up in the reaction only a very small amount is required.

b) The low temperature means the molecules have less kinetic energy. Therefore, when the molecules collide there is less chance of reaching the activation energy for the reaction and therefore the reaction rate is decreased. Also, there will be a decrease in the frequency of collisions of molecules. Therefore, there are fewer successful collisions in the same time, so that the reaction rate is decreased and the rate of decomposition is decreased.

11) Decrease / less time or similar / faster rate
An increase in temperature means the particles have more kinetic energy. An increased number of collisions of particles, in a given time, will now reach the activation energy required for the reaction. Also there will be more collisions / time. Therefore, the frequency of successful collisions will increase. Thus the reaction rate is increased so the time required for reaction is decreased.